Traumatic Brain Injury (TBI) Overview

Author: Abubaker Salman

According to modern trauma guidelines and updated neurosurgical practice.

---

1) Classification of TBI

A. Mild TBI (Concussion)

Definition

Glasgow Coma Scale (GCS): 13–15. Temporary neurological dysfunction after trauma.

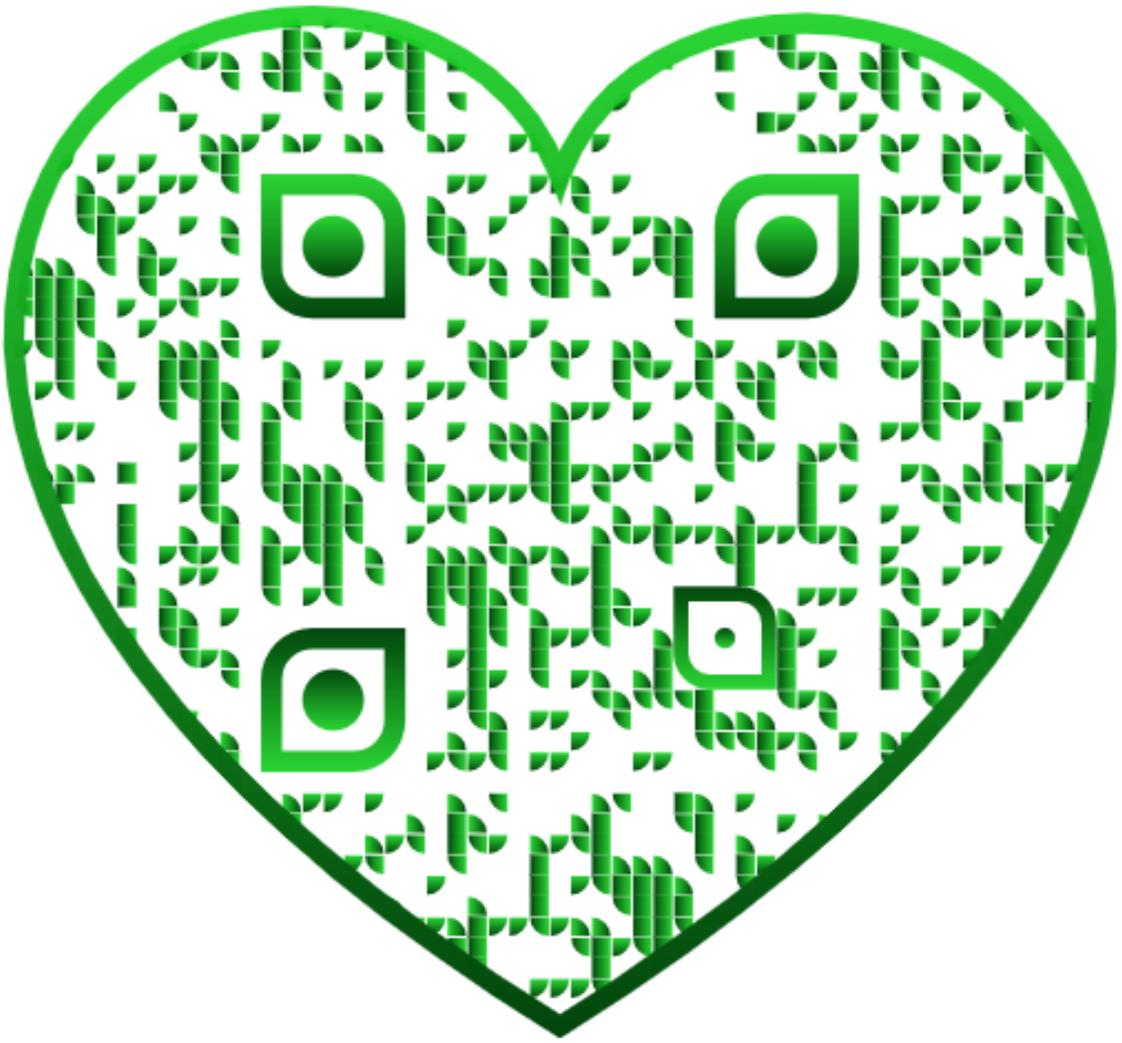
Common Symptoms

Headache, Nausea/vomiting, Dizziness, Brief loss of consciousness, Amnesia, Confusion.

CT Brain

Usually normal. May show mild cerebral edema.

Pathophysiology



Functional neuronal injury without major structural damage.

Management

Observation, Analgesia (avoid excessive sedation), Antiemetics, Neurological monitoring for 24 hours, Avoid sports/heavy activity until recovery.

Admission Indications

Persistent vomiting, Anticoagulant use, Abnormal CT, Seizure, Elderly patient, Decreasing GCS.

Anticonvulsants

Not routinely indicated unless seizure occurs or cortical injury exists.

B. Moderate TBI - Brain Contusion

Definition

Focal bruising of brain tissue with petechial hemorrhage and edema.

Common Sites

Frontal lobe, Temporal lobe.

CT Findings

Mixed hyperdense hemorrhagic areas, Surrounding edema.

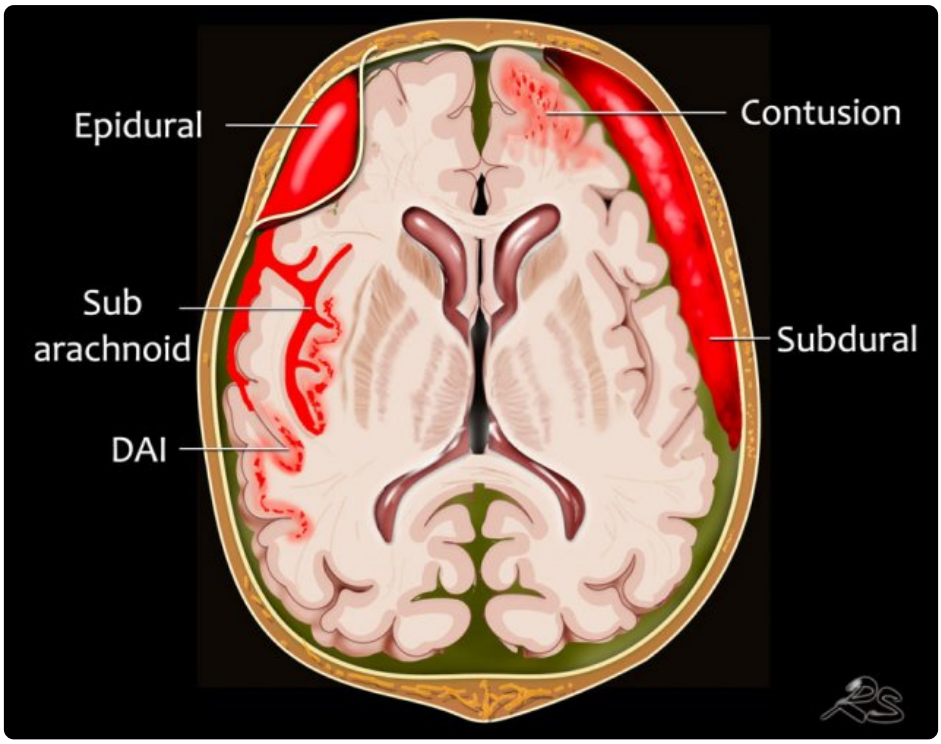


Figure 1: CT showing Brain Contusion with mixed density.

Symptoms

Altered consciousness, Focal neurological deficit, Headache/vomiting, Seizures.

Complications

Increased intracranial pressure (ICP), Expansion of hemorrhage, Seizures.

Management

ICU/ward admission depending on GCS, Serial neurological examination, Repeat CT within 6–24 h if worsening, Anticonvulsants for 7 days in high-risk patients. Common prophylaxis: Levetiracetam, Phenytoin.

Surgery Indications

Large contusion with mass effect, Midline shift, Neurological deterioration.

C. Severe TBI - Diffuse Axonal Injury (DAI)

Definition

Widespread shearing injury of axons due to acceleration/deceleration trauma.

Common Sites

Corpus callosum, Brainstem, Gray-white junction.

Clinical Picture

Coma disproportionate to CT findings, Severe neurological deficit.

CT Findings

May be normal initially, Small petechial hemorrhages.

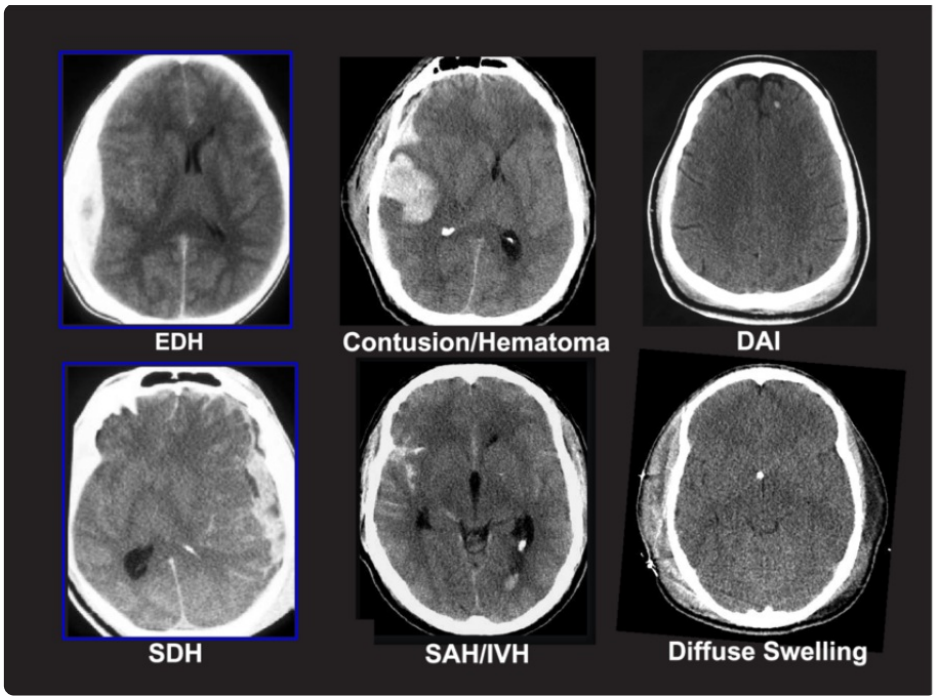


Figure 2: MRI is more sensitive than CT for detecting Diffuse Axonal Injury (DAI).

Best Diagnostic Tool

MRI brain is more sensitive.

Management

ICU admission, Airway protection and mechanical ventilation, ICP control, Hemodynamic support, Rehabilitation.

Prognosis

Depends on severity and brainstem involvement.

---

2) Role of Brain CT in TBI

CT is done to detect: Intracranial hemorrhage, Skull fractures, Midline shift, Brain edema, Herniation, Hydrocephalus.

Urgent CT Indications

GCS <15 after trauma, Loss of consciousness, Vomiting, Skull fracture signs, Focal neurological deficit, Seizure, Anticoagulant therapy.

---

3) Skull Fractures

① Linear Skull Fracture

Definition

Simple non-displaced fracture.

Management

Observation if asymptomatic.

Special Situation

Frontal sinus involvement may require: Cranialization, Repair to prevent: CSF leak, Pneumocephalus, Infection.

② Depressed Skull Fracture

Definition

Bone depressed below inner skull table.

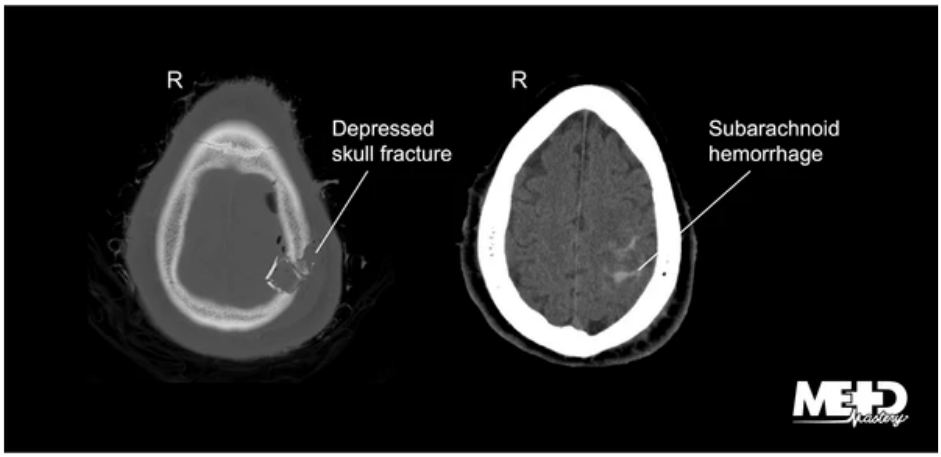


Figure 3: CT showing Depressed Skull Fracture.

Surgical Indications

Depression > skull thickness, Cosmetic deformity, Dural tear, Neurological deficit, Contamination.

Management

Surgical elevation, Debridement if open fracture.

Infant Type

“Ping-pong fracture” - Often managed conservatively.

③ Compound Skull Fracture

Definition

Open skull fracture with scalp laceration ± fragmentation.

Risks

Infection, Osteomyelitis, Meningitis.

Management

Broad-spectrum antibiotics, Debridement, Surgical fixation.

Reconstruction

Cranioplasty later if needed.

④ Basal Skull Fracture (BSF)

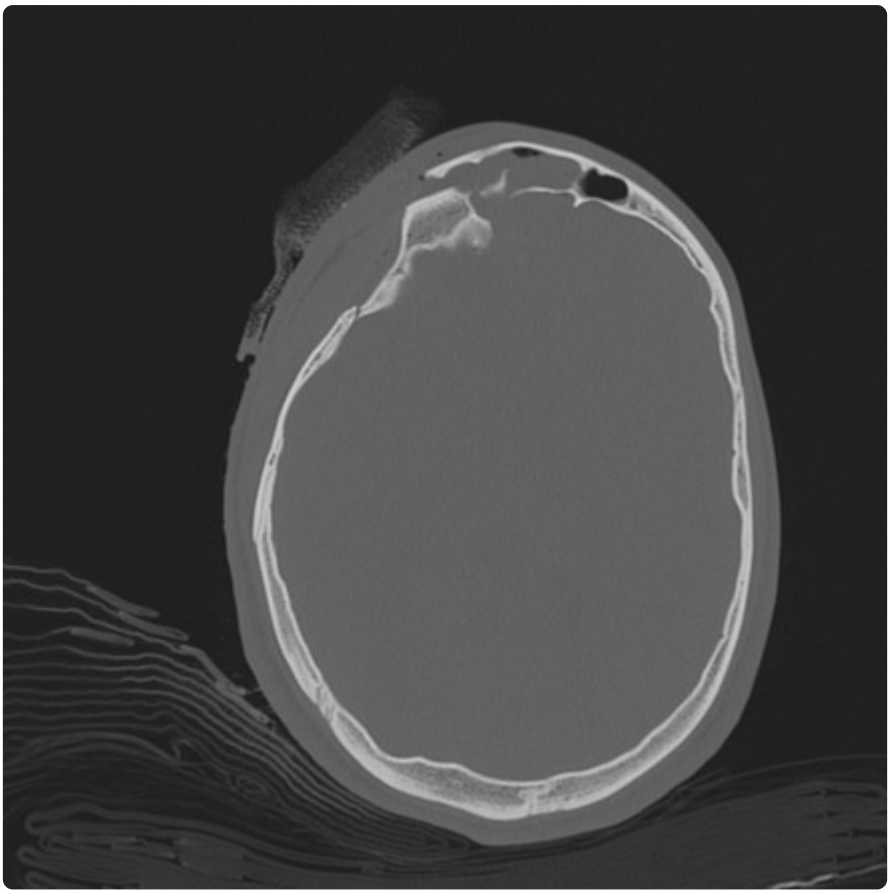


Figure 4: CT findings in Basal Skull Fracture.

Clinical Signs

Anterior Cranial Fossa: Raccoon eyes.

Middle Cranial Fossa: Otorrhea, Rhinorrhea, Hemotympanum.

Posterior Cranial Fossa: Battle sign.

Important Complications

CSF leak, Meningitis, Cranial nerve palsies.

Diagnosis

CT skull base, Beta-2 transferrin for CSF leak, MRI cisternography if persistent leak.

Management According to Guidelines

Most cases → conservative initially: Bed rest, Head elevation, Avoid nose blowing.

Antibiotics

Routine prophylactic antibiotics are controversial internationally and not routinely recommended by many guidelines because evidence for meningitis prevention is weak. However, in high-risk settings with prolonged CSF leak and limited follow-up, some centers may use antibiotics individually.

Surgery Indications

Persistent CSF leak >7–14 days, Recurrent meningitis, Large dural tear.

---

4) Intracranial Hemorrhage

A. Extra-cranial Hemorrhage

Examples

Scalp hematoma, Subgaleal hematoma.

Management

Usually observation and compression.

B. Intra-cranial Hemorrhage

Types

1. Subdural hemorrhage
2. Epidural hemorrhage
3. Intraparenchymal hemorrhage

4. Subarachnoid hemorrhage
5. Intraventricular hemorrhage

① Subdural Hemorrhage (SDH)

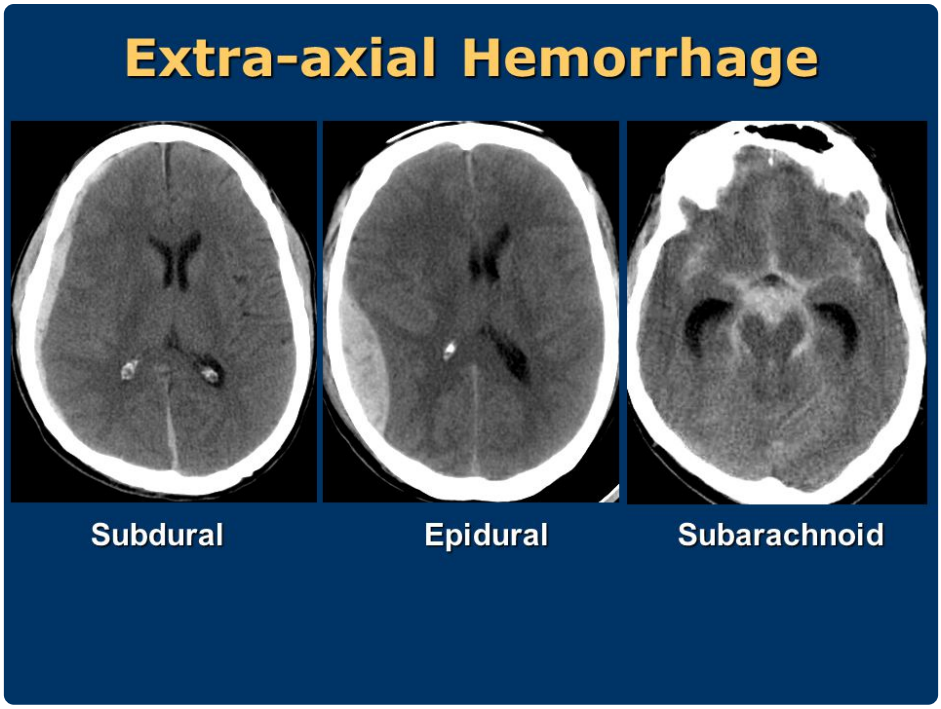


Figure 5: Comparison of Subdural (Crescent) and Epidural (Lens) Hemorrhage.

Source

Bridging veins.

Location

Between dura and arachnoid.

Shape on CT

Crescent/Banana shape.

Classification

Acute: 0–3 days → hyperdense

Subacute: 4–13 days → isodense

Chronic: > 14 days → hypodense

Surgical Indications

Thickness >10 mm, Midline shift >5 mm, Neurological deterioration, Raised ICP.

Management

Acute SDH: Craniotomy/craniectomy

Subacute SDH: Burr hole or craniotomy

Chronic SDH: Burr hole drainage

② Epidural Hemorrhage (EDH)

Source

Middle meningeal artery.

Location

Between skull and dura.

Shape

Lens/Lemon shaped.

CT Characteristics

Biconvex hyperdense lesion. Does NOT cross suture lines.

Clinical Feature

Lucid interval may occur.

Emergency

Neurosurgical emergency due to arterial bleeding.

Management

Urgent craniotomy: 1. Evacuation, 2. Hemostasis, 3. Dural hitching.

Surgical Indications

Volume >30 cm^3, GCS deterioration, Focal deficit.

③ Intra-parenchymal Hemorrhage

Definition

Bleeding inside brain tissue.

Causes

Trauma, Hypertension, AVM, Tumor.

CT

Irregular hyperdense lesion with edema.

Management

Depends on: Age, Location, Dominant hemisphere, Neurological status.

Surgery Considered If

Mass effect, Herniation risk, Young patient, Accessible lesion.

④ Subarachnoid Hemorrhage (SAH)

Location

Subarachnoid space.

CT Appearance

Blood in sulci and cisterns (“finger-like”).

Causes

Traumatic: Most common overall.

Spontaneous: Aneurysm, AVM, Hypertension.

Complications

Vasospasm, Hydrocephalus, Rebleeding, Hyponatremia.

Management

ICU Admission: Essential.

Medical Treatment: Blood pressure control, Analgesia, Anticonvulsants selectively, Nimodipine to prevent vasospasm.

Standard Regimen: Nimodipine 60 mg every 4 hours for 21 days.

Aneurysm Treatment

1. Coiling (Endovascular approach), 2. Clipping (Open surgical approach).

Current Guidelines: Endovascular coiling is preferred in many aneurysms when anatomically suitable.

⑤ Intraventricular Hemorrhage (IVH)

Definition

Bleeding into ventricular system.

Complications

Obstructive hydrocephalus, Increased ICP.

Management

ICU care, ICP monitoring, External ventricular drain (EVD) if hydrocephalus develops, Shunt (usually delayed until infection risk decreases and hydrocephalus persists).

Important ICU Principles in Severe TBI

Airway

Intubate if GCS ≤8.

Blood Pressure Targets

Maintain cerebral perfusion, Avoid hypotension.

ICP Control

Head elevation 30°, Sedation, Hyperosmolar therapy (Common agents: Mannitol, Hypertonic saline).

Seizure Prophylaxis

Usually for 7 days in severe TBI.

DVT Prophylaxis

Mechanical first, then pharmacologic once bleeding stable.

Important Modern Guideline Notes

1. Steroids are NOT recommended in TBI due to increased mortality.
2. Hypotension and hypoxia worsen outcomes significantly.
3. Repeat CT is important if neurological status worsens.
4. Early rehabilitation improves long-term outcomes.
5. ICP monitoring recommended in severe TBI with abnormal CT.

Rapid CT Shape Comparison

SDH: Crescent shape (Source: Veins)

EDH: Lens/Biconvex shape (Source: Artery)

SAH: Sulcal/Finger-like shape (Source: Subarachnoid vessels)

IPH: Irregular shape (Source: Brain vessels)

IVH: Ventricular blood (Source: Ventricular extension)